AUTOMATIC COVER APPLICATOR

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority based upon of U. S. provisional application number 60/440,380 filed January 16, 2003.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not Applicable.

REFERENCE TO SEQUENCE LISTING, A TABLE, OR A COMPUTER PROGRAM LISTING COMPACT DISK APPENDIX

[0003] Not Applicable.

BACKGROUND OF THE INVENTION

[0004] Large heavy industrial products often comprise natural materials such as composite materials, engineered wood products, lumber, prefabricated engineering products, building construction materials, and the like. These materials are often packaged and shipped in open boxlike crated forms. It is important that such products be protected from damage during shipping and handling. Often damage can occur to the ends and corners of such material. For example, products such as stacks of plywood or composite particle board can sustain damage during shipping to any exposed areas of the stack but corners and edges are most prone to chipping or other damage as a result of transportation and handling. Damage to edges and corners of stacked building materials is unacceptable to retailers and renders the damaged product pieces unmarketable.

[0005] Moisture control has also been a concern with such products and several devices exist for wrapping product with plastic material. Wrapping, however, does not eliminate or reduce the potential for physical damage to the ends, sides, surfaces and edges of stacked wood or composite products.

BRIEF SUMMARY OF THE INVENTION

[0006] In one aspect of the invention, an applicator apparatus is provided which applies a protective cover to a product such as a stack of flat sheets of building material. A platform supports the product in a predetermined orientation. Adjacent the platform is a frame which

supports a cover manipulator. The cover manipulator is mounted on a transport on the frame and operates to grasp a protective cover from a cover magazine. The transport mechanism is operable to move the cover manipulator from a position adjacent the cover magazine to a second position adjacent the platform. The applicator then presses the cover against the product in a predetermined orientation and a fastening mechanism secures the cover to the product. Typically, the cover is a flat sheet of cardboard or similar protective material. The material has scored or relieved portions which permit its top and ends to be folded over the end of the product to which it is applied. The material may then be rotated on a platform adjacent the frame so that another cover can be applied to the opposite end.

[0007] The foregoing and other objectives, features and advantages of the invention will be more readily understood upon consideration of the following detailed description, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE SEVERAL DRAWINGS

[0008] FIG. 1A is a top schematic view of a material handling system which includes a cover applicator apparatus.

[0009] FIG. 1B is a side elevation view of the apparatus of FIG. 1A.

[0010] FIG. 2 is an end view taken along line A of FIG. 1A.

[0011] FIG. 3 is a side elevation view taken along line B of FIG. 1A.

[0012] FIG. 4 is a partial rear view of a folding and fastening mechanism attached to a protective cover prior to its affixation to a package of material.

[0013] FIG. 5 is a partial rear view of the apparatus of FIG. 4 with the cover folded over and attached.

[0014] FIG. 6 is a side elevation view of a second embodiment of a protective cover applicator apparatus.

[0015] FIG. 7A is a partial side view of a rotating turntable for positioning product for the cover applicator apparatus.

[0016] FIG. 7B is a partial side view of the apparatus of FIG. 7A with the turntable lifted and partially rotated.

[0017] FIG. 8 is a partial side cutaway view of the apparatus of FIG. 1 taken along line C.

[0018] FIG. 9A is a top sectional view of a moving cage which forces a protective cover to fold over portions of the top, end and sides of a product.

[0019] FIG. 9B is a front view of the cage of FIG. 9A.

[0020] FIG. 9C is a sectional side view of the cage of FIG. 9A.

[0021] FIG. 9D is a side view of a form of the protective cover to be folded onto the product by the cage of FIGs. 9A-C.

[0022] FIG. 10 is a block schematic diagram of a control system for automatically operating the apparatus of FIGs. 1A and 1B.

[0023] FIG. 11 is a side elevation view of third embodiment of an applicator apparatus for applying a protective cover to a product.

[0024] FIG. 12 is a partial front view of the apparatus of FIG. 11.

[0025] FIG. 13 is a partial side elevation view of a magazine for holding a stack of protective covers.

[0026] FIG. 14 is a partial side elevation view showing the protective cover applicator of FIG. 11 in actual operation.

[0027] FIG. 15 is a side elevation view of the protective cover applicator of FIG. 14 with the cover

pressed against the product.

[0028] FIG. 16 is a side elevation view of a protective cover applicator of FIG. 14 with the cover folded over the ends of the product.

[0029] FIG. 16A is a front view of the protective cover applicator of FIG. 16.

[0030] FIG. 17 is a partial top view of the protective cover applicator of FIG. 16.

[0031] FIG. 18 is a partial side view of the protective cover applicator of FIG. 11 illustrating the operation of the rotary turntable supporting the product.

DETAILED DESCRIPTION OF THE INVENTION

[0032] Referring to FIGS. 1A and 1B, a system for inspecting, protective cover application and banding large and heavy industrial products typically in rectangular boxlike form is illustrated. The system employs a powered conveyor assembly 1 to move a product along a path so as to enter workstations for visual inspection 15, cover application 13 and banding 6 of the product for ease of handling, protection and transporting. The visual inspection 15 workstation consists of at least two polarized light illumination devices 2 and at least two line-scan video cameras 17. The video cameras 17 provide images of the product 16 side and edge surfaces for a means of allowing the operator to remotely view and detect the presence of product damage before application of covers. Depending upon the type of product additional cameras may be integrated into the system for means of examining the product 16 upper surface and leading and trailing end surfaces. The images obtained for each individual product 16 are also transmitted to a computer controlled image storage and retrieval system. This image storage and retrieval system provides a means of providing evidence as to the state of the product before it was shipped and received by the customer.

[0033] In its simplest form, the cover application 13 workstation receives a product 16 in a generally precise location and orientation to the automated cover installer 18. Accurate positioning of the product 16 is obtained through an arrangement of electronic position sensors 4 and mechanical devices, which guide and force the paralleling of all sides and ends of the product 16. The height of the product 16 is also determined by a combination of electronic and

mechanical means so as to provide further accurate alignment with cover installer 18. The cover installer transport 11 is a powered assembly of guides, slides and rollers, which traverse along path 9. The cover installer transport 11 also serves to raise and lower the integrally attached cover installer 18 and cover holder 19. The cover installer transport 11 provides the means moving cover installer 18 to a supply of covers 12 and then manipulate cover holder 19 for retrieving a new cover 12 and then moving cover installer 18 to the side of product 16 to engage cover holder 19 and attach the cover 12. Having attached a cover 12 to one side, installer transport 11 moves to obtain another new cover 12 from the source. During this operation x-y table 3, adjustable between 0 and 360 degrees in increments, is energized and rotates product 16 180 degrees so as to place the product's uncovered side ready to receive a cover 12. Because the cover applicator 13 workstation is constructed in modular form it is therein possible to attach and arrange additional modules for means of attaching covers to the opposite side as well as to the top surface, front and rear surfaces of the product 16 when greater through-put and productivity is desired. This operation is performed in an automated and sequenced operation.

[0034] The product banding 6 workstation serves to further process the now covered product by banding it with locking straps 7 for means of restraining any movement of the articles, which comprise the product 8. The banding 6 workstation also creates a label and/or tag which identifies the contents and condition of the product obtained from the electronic visual inspection records stored in the a computer and obtained previously from the visual inspection 15 workstation. Sensors 5 and 10 serve to detect the movement and location of the product has it enters and leaves the workstation.

[0035] The arrangement of the visual inspection 15, cover installation 13 and banding 6 workstation, along a common and shared conveyor 1 provide a logical order in a sequence of operations necessary in concluding the packaging of a product before it is shipped to a customer. No one operation can be omitted. It also possible to extend the distance between workstations, while using a common and shared conveyor, to accommodate for available space within a facility or for closer Proximity to other workstations in the manufacturing process of the product. It is also further possible to separate one or more workstation from the common and shared conveyor and employ some other form of conveyance device to move the product from workstation to workstation where distance prohibits close proximity of workstations.

[0036] Referring to FIG. 2 is a cross-section illustration, as identified in FIG. 1 by A, of the visual inspection workstation. The product 22 is entered into the field of illumination provided by lamps 20 and view of video cameras 21 by powered conveyor 24. At least one sensor 23 is used to detect the entry and exist of the product 22 into the workstation. Sensing entry into the workstation the sensor 23 initiates energizing lamps 20 and video cameras 21. As the product moves through the workstation image information from both sides of the product 22 is transmitted to a central processing unit where it is simultaneously stored and identified by a product article number, date and time. The image information is also presented to the system operator through a computer monitor for means of examining the product for possible damage. To enhance visual detection polarized light and the angle of illumination are controlled so as to reduce reflection and improve the definition of product defects and damage. When greater definition and resolution is required for detecting product defects several video cameras 21 and illuminators 20 can be arranged to provide a 3-dimension image using computer software applications. Additional cameras may also be included to examine the front, rear and upper surfaces of the product. To meet a variety of inspection requirements peculiar to various types of products still imaging, line scan and motion video imaging may be combined in various arrangements. Ultraviolet and Infrared illumination in combination with respective types of imaging systems may also be employed for inspecting special types of products.

[0037] Referring to FIG. 3 is a cross-section illustration, as identified in FIG. 1 by B, of the cover applicator workstation. The cover applicator serves to attach protective covers to the sides, ends and upper surface of a rectangular box like shaped product. There are many forms and configurations of covers the cover applicator is adapted to installing and attaching to products. A product entering into the cover applicator workstation is detected by sensor 37, which serves to determine its length, and initiates a signal to an electrical-mechanical device to provide a hard stop to the product and therein precisely position the product within the workstation. A powered shuttle like transport 27 using several opposing sets of rollers on at least two interlocking tracks 25 is moved over a precise path 39 by power source 26. Integral to the transport 27 is an assembly of one or more sets of at least two telescoping sleeves 28 in combination and coaxial arrangement. The outer sleeve being generally fixed to the transport 27 and the inner sleeve 28 being allowed to move up and down along path 38. Further, that a combination of bushings and/or bearing devices 34 are used to maintain precise alignment between outer sleeve and inner sleeve during longitudinal travel of the inner sleeve within the outer sleeve. Raising and lowering

of the inner sleeve, along path 38, may be performed by a combination of various types of motors and actuating devices suited for precise movement and control of the cover holder 29. To retrieve a new cover the inner sleeve is raised up and the cover holder 29 is pivoted up 90 degrees from its normal position by actuator 33. The transport 27 is moved, over path 39, to a stack of covers 31. The inner sleeve is lowered to allow the cover holder 29 to make contact with upper most cover. Vacuum is applied to a series of cup like devices for grasping the cover. The transport 27 then moves towards the product and the cover holder 29, while holding a cover, is lowered to its normal position by actuator 33. Height information of the product obtained by sensor 35 is used by a controller to precisely align the cover 31 with the product cover attachment surface. A pressure roller 36 first engages the product upper surface so as to provide sufficient pressure to serve to detect the movement and location of the product has it enters and leaves the workstation.

[0038] The arrangement of the visual inspection 15, cover installation 13 and banding 6 workstation, along a common and shared conveyor 1 provide a logical order in a sequence of operations necessary in concluding the packaging of a product before it is shipped to a customer. No one operation can be omitted. It also possible to extend the distance between workstations, while using a common and shared conveyor, to accommodate for available space within a facility or for closer proximity to other workstations in the manufacturing process of the product. It is also further possible to separate one or more workstation from the common and shared conveyor and employ some other form of conveyance device to move the product from workstation to workstation where distance prohibits close proximity of workstations.

[0039] Referring to FIG. 2 is a cross-section illustration, as identified in FIG. 1 by A, of the visual inspection workstation. The product 22 is entered into the field of illumination provided by lamps 20 and view of video cameras 21 by powered conveyor 24. At least one sensor 23 is used to detect the entry and exist of the product 22 into the workstation. Sensing entry into the workstation the sensor 23 initiates energizing lamps 20 and video cameras 21. As the product moves through the workstation image information from both sides of the product 22 is transmitted to a central processing unit where it is simultaneously stored and identified by a product article number, date and time. The image information is also presented to the system operator through a computer monitor for means of examining the product for possible damage. To enhance visual detection polarized light and the angle of illumination are controlled so as to reduce reflection and

improve the definition of product defects and damage. When greater definition and resolution is required for detecting product defects several video cameras 21 and illuminators 20 can be arranged to provide a 3-dimension image using computer software applications. Additional cameras may also be included to examine the front, rear and upper surfaces of the product. To meet a variety of inspection requirements peculiar to various types of products still imaging, line scan and motion video imaging may be combined in various arrangements. Ultraviolet and Infrared illumination in combination with respective types of imaging systems may also be employed for inspecting special types of products.

[0040] Referring to FIG. 3 is a cross-section illustration, as identified in FIG. 1 by B, of the cover applicator workstation. The cover applicator serves to attach protective covers to the sides, ends and upper surface of a rectangular box like shaped product. There are many forms and configurations of covers the cover applicator is adapted to installing and attaching to products. A product entering into the cover applicator workstation is detected by sensor 37, which serves to determine its length, and initiates a signal to an electrical-mechanical device to provide a hard stop to the product and therein precisely position the product within the workstation. A powered shuttle like transport 27 using several opposing sets of rollers on at least two interlocking tracks 25 is moved over a precise path 39 by power source 26. Integral to the transport 27 is an assembly of one or more sets of at least two telescoping sleeves 28 in combination and coaxial arrangement. The outer sleeve being generally fixed to the transport 27 and the inner sleeve 28 being allowed to move up and down along path 38. Further, that a combination of bushings and/or bearing devices 34 are used to maintain precise alignment between outer sleeve and inner sleeve during longitudinal travel of the inner sleeve within the outer sleeve. Raising and lowering of the inner sleeve, along path 38, may be performed by a combination of various types of motors and actuating devices suited for precise movement and control of the cover holder 29. To retrieve a new cover the inner sleeve is raised up and the cover holder 29 is pivoted up 90 degrees from its normal position by actuator 33. The transport 27 is moved, over path 39, to a stack of covers 31. The inner sleeve is lowered to allow the cover holder 29 to make contact with upper most cover. Vacuum is applied to a series of cup like devices for grasping the cover. The transport 27 then moves towards the product and the cover holder 29, while holding a cover, is lowered to its normal position by actuator 33. Height information of the product obtained by sensor 35 is used by a controller to precisely align the cover 31 with the product cover attachment surface. A pressure roller 36 first engages the product upper surface so as to provide sufficient pressure to

restrain movement if the product. The transport 27 moves forward to compress the cover against the product surface. Where the protective cover configuration consists of multiple panel like flaps, extending from the primary cover, the cover holder 29 will manipulate a series of power driven plates to fold the additional flaps over and onto the upper and end adjacent surfaces. The cover 31 is then attached to product surfaces by means designated by the cover manufacturer and which could comprise mechanical fasteners such as, nails, stapling, adhesive, gluing and Velcro fasteners to name a few examples. The cover 31 stack is maintained at a constant height by an automated powered device 32 and provides an alarm when feed height falls below designated level. The cover stack is further aligned so as to place all cover edges parallel to one another through means of an automated alignment fixture 30.

[0041] Referring to FIG. 4 is a rear view of the cover holder. The function of the cover holder is to retrieve, grasp and apply a new protective cover to products having a rectangular box-like shape. It is further capable of folding over panel like flaps extending from the primary cover so as to place them generally parallel to adjacent surfaces of the box-like product shape. Once folded down the entire cover will be securely attached to the product by means of stapling, gluing or Velcro fastening. Cover holding plate 44 (backside shown) attaches to the cover installer transport (FIG.1) and is comprised of actuators 42, 50, 53 and vacuum operated cover grippers 51. Plates 41, 47 and 54 are attached to holding plate 44 through hinges 52, 48 and 49. Actuators 42, 50 and 53 serve to retract and hold plates 41,47 and 54 in the open position during the retrieval and transporting of a new protective cover to the product surface. The actual securing of the cover to the holding plate 44 is provided means of several vacuum operated grippers 51 precisely placed and secured to the cover plate 44. The vacuum grippers 51 are feed-through devices that protrude on the reverse surface of the cover holding plate 44. Another configuration is a flat shallow rectangular shaped chamber, exhibiting a large number of precisely spaced holes on one surface only and when vacuum is applied serve as the cover gripper. In this configuration the chamber is integrated into the construction of the cover holding plate 44. Also precisely placed on plates 41, 47 and 54 are several powered staplers 40, 43 when stapling is a required means of cover attachment. Additional provisions for folding tabs, present in certain types of covers, are smaller plates 45 and 56 hinged 46 to plates 47 and 54. These plates are also operated by actuators 55 to fold cover tabs down and may comprise a powered stapler 40 when this is the required method attachment.

[0042] Referring to FIG. 5 is a rear view of the cover holder. In this view the actuators 65, 62 and 61 are in the extended position so as to place the plates 59, 60, 64 and smaller plates 57 inwards and therein place the cover extended panels on the adjacent surfaces of from the primary larger cover. Several powered staplers 66, 58 are now actuated as one form of attachment method. With completion of the cover attachment vacuum is then removed from vacuum gripper 63 and the cover holder is removed from compression with the product surface.

[0043] Referring to FIG. 6 is a cross-section illustration, as identified in FIG. 1 by B, of another cover applicator workstation designed for installing a different form of cover. The cover applicator also serves to attach preformed covers to the sides, ends and upper surface of a rectangular box like shaped product. There are many forms and configurations of covers the cover applicator is adapted to installing and attaching to products. A product entering into the cover applicator workstation is detected by sensor 84, which serves to determine its length, and initiates a signal to an electrical-mechanical device to provide a hard stop to the product and therein precisely position the product within the workstation. A powered shuttle like transport 69 using opposing sets of rollers on two interlocking tracks 68 is moved over a precise path 72 by power source 67. Integral to the transport 69 is an assembly of one or more sets of at least two telescoping sleeves 70 in coaxial arrangement. A powered drive 71 is used to rotate telescoping sleeves 70 about their coaxial center to provide an additional means for aligning cover holder 79 with product 82 surface. The outer sleeve being generally fixed to the transport 69 and the inner sleeve being allowed to move up and down along direction 73. Further that a combination of bushings and/or bearing devices is used to maintain precise alignment between outer sleeve and inner sleeve during longitudinal travel of the inner sleeve within the outer sleeve. Raising and lowering inner sleeve 70, along direction 73, may be performed by a combination of motors and actuators. To retrieve a cover the inner sleeve is adjusted to a predetermined position and the cover holder 80, in its normal position, is rotated 90 degrees by actuator 81. The transport 69 is moved over a precise path 72 towards a vertically positioned source of covers 76. The inner sleeve may be further adjusted to accommodate variations in cover dimensions before cover holder 79 makes contact with the first cover. Vacuum is applied to a series of cup like devices for grasping the cover or means, which use vacuum means for gripping a surface. The transport 69 then moves towards the product and during this period the inner sleeve 70 is rotated 180 degrees so as to position the cover holder 79, while holding the cover, now facing the product surface to be covered. Product height information, obtained by sensor 83, is used by a controller to precisely align the cover with

the product cover surface. A pressure roller, such as described in FIG.3, may be used to engage the product upper surface so as to provide sufficient pressure to restrain movement if the product is comprised of loose unbound sheet articles. The transport 69 moves forward to compress the cover holder 79 and cover against the product 82 surfaces. Where the cover configuration consists of multiple panel like flaps, extending from the primary cover, the cover holder 79 will manipulate a series of power driven plates to fold the additional flaps over and onto the upper and end adjacent surfaces. The cover is then attached to product surfaces by means designated by the cover manufacturer and which could comprise stapling, adhesive, gluing and Velcro fasteners. Cover stack alignment and feeder 78 are automated to the extent that a single cover 76 is always made present in a loading tray. The cover stack is further aligned so as to place all cover edges parallel to one another through means of powered alignment plates located within feeder 78. Actuator 75 operates cover control plates 74 in manner so as to allow the removal of a single cover 76 while simultaneously controlling the forward movement of covers. The forward movement of covers in the cover feeder 78 is performed by means of a device 77, which places a constant preload pressure on the cover stack.

[0044] Referring to FIG. 7A and B is an illustration showing a powered X-Y table 92 capable of supporting substantially greater than 10,000 pounds. The table 92 provides the means for rotating a product 85, by means of rotating table section 93 over fixed position table 91. Rotating product 86 provides a means for positioning each of four sides, in a sequenced operation, to a single cover installer. Where only two cover installers are employed the table 92 provides the means for rotating the product 85 so as to present two of four sides, in a sequenced operation, to two oppositely opposed cover installers. Position control and indexing of table section 90 is provided by means of actuators providing lifting and rotation movement of at least one cylinder 87. Precise indexing is provided by means of a positive protruding wedges located on table section 90 that engages a mating surfaces on table section 88. Any number of other multiple and different means of indexing may also be applied.

[0045] Referring to FIG. 8 is a cross-section illustration, as identified in FIG. 1 by C, of the product cover banding workstation. The workstation is comprised of an automated banding machine 94 and a computer generated tag printer and applicator 95. As a product 96 enters the workstation sensor 97 detects its presence and initiates a signal to the system controller. The controller retrieves the information on the product and initiates the printing of an identification code for the

product, which has been visually inspected, covered and now banded.

[0046] Referring to FIG. 9 are several top, front and side views of a device for installing protective covers onto products surfaces through such means as to allow simultaneously folding extending cover panels onto product surfaces without the need of powered manipulating devices. Included also is a view of a typical protective cover. A new protective cover 116 is retrieved and held by vacuum present from several holes located on the surface of vacuum plate 112 which is attached to plate 111. Plate 111 is also attached to at least two guides 110 which originate from a powered motor or actuator and which serve to move and place plate 111 and cover 116 to make contact with the product surface. A box like cage 107 also shares guides 110, guides 108 and bearings 109, so as to operate in arrangement and in combination with plate 111. When the protective cover 116 is placed against the product surface by vacuum plate 112 and plate 111, forward motion of the cage 107 towards the plate 111 is initiated. The cage 107 walls leading inner edges are aligned so as to make contact with the outside perimeter of one or more marking or creases present on the protective cover to be installed. Forward motion for cage 107 is provided by a powered motor or actuator. Cage 107 travels along a controlled path, provided by guides 110 and as the cage 107 walls engage cover 116 top panel 115 and side panels 113 they are forced beneath the cage walls. The continuing forward motion of the cage 107 places the cover panels parallel to the three surfaces of the product. When the cage 107 stops an attachment means is then initiated to secure all sections of the cover to the product's three surfaces. Some protective covers produced employ additional small tab 114 like folding panels, which are placed either below or above the cover's top 115 folding panel. Two methods for folding these additional panel tabs 114 are described. These methods are integrated into the upper wall of the cage 107. A top section view of cage 107 upper wall 99 is shown with a protruding tab 101 and front view of cage 107 with protruding tab 105. As the upperwall of cage 107 engages the top panel 115 of the cover 116 the protruding tab 101 and 105 start engaging the small tab 114 located on side panel 113 of the cover. The protruding tab 101, 105 serves to start pushing the small tab 114 on the cover side panel 113 down onto the top panel 115. As the cage 107 travels further in towards the cover 116 the sidewall 106 now starts folding the cover side panel 113 inwards. The continuing forward travel of the cage 107 allows upper wall 99 to first complete folding top panel 115 down as the protruding tab 101, 105 progressively fold the cover's side panel 113 small tab 114 inward and down against cover top panel 115. Cage 107 side walls 106 also simultaneously folds the cover side panel down. The same process takes place when the small tab 114 on the cover side

panel 113 is to be placed beneath the cover's top panel 115. In this operation the cage 107 sidewall 104 is first to engage the cover's side panel. As wall 104 progresses forward lip 102, 103 starts to fold the side panel tab down. When the cage 107 upper wall 98 engages the cover's top panel and moves forward the cover's side panel small tab 114 is now nearly compressed down so as to allow the cover's top panel 115 to rest above the small tab 114. Several means are now possible for attaching the protective cover to the product's surface or to members of a crate containing the product.

[0047] Referring to 10 is a block diagram showing the various components and controls employed for the operation of this invention. Product leading and training edge sensors 117 is employed to detect the entry and egress of a product into a workstation. They provide such information necessary to control the actuation of other devices, the speed and stopping of the product through the workstation. Product height sensors 118 serve to measure the height of the product above the conveyor plane of reference. This information serves to provide information to the controller, which may adjust the position of other devices intended to contact and engage the product. The X-Y positioning sensors 119 provide information as to the actual location of the table and product relative to the cover installer. The information will confirm that the product is properly aligned or that there may be a fault present in the alignment. In such a condition the cover installer is inhibited from its operating mode. Conveyor speed sensors 120 serve to provide accurate information on the performance the material handling system. Safety and Alarm sensors 121 serve to detect failures in device and system operation, which may be hazardous to continued system operation or operating personnel. Protective cover applicator X-Y position sensors 122 are those sensors employed to detect and measure the precise location of cover installer relative the product to be covered. They operate within a closed-loop feedback system to provide information for proportional control of servos, actuators and motors necessary for precise engagement of the cover to the product surface geometry. Conveyor stop sensors 123 serve to initiate power shut down in event of component or system failure. End of line sensor 124 serve to alert that a product has completed the process and is now ready for removal. The product inspection camera stations 128 serve to illuminate by means of camera station lighting 127 and take high-resolution real-time video images of all designated surfaces of the product through cameras 129 before it is covered. The visual images are presented to the system operator on a monitor 132 for remote viewing and examination of the product condition. The image information is also transmitted to a computer 130 where the image file is compressed into an acceptable format and then placed into

CD-ROM archiving. Manual control and operation of the system is provided through control panel 125. The operator has the option of manually controlling each interdependent operation performed in each of three workstations. The operator also has the option of selectively and fully automating workstations through controller 126. This allows the means for dealing with varying product configurations entering the system. This is also an important feature and capability when the system employs five cover installing assemblies and product configurations vary. In a fully automated operation of the system a central controller 126 uses the data provided by all sensors and operator requirements to manage and operate the inspection workstation components 128, Cover applicator workstation 133 and Banding workstation 135. When a product has been fully processed, information stored in the central controller on that product is transmitted to inspection tag printer 131 where a tag or label is produced. The printed tag or label is then attached to the product by means of an automated inspection tag applicator 134. Monitor 132 is primarily used by the system operator to remotely view the surfaces of the product for the presence of damage. Multiple real time digital imaging devices such as still cameras, line scan and continuous motion video cameras are used in various arrangements in order to inspect a wide variety of surfaces, which are possible in products. The inspection images are presented on the monitor 132 in an operator controlled sequence or possibly on several monitors, one for each surface under inspection. In a more advanced version an arrangement of computer software, sensors and imaging devices can be programmed and used to detect damaged surfaces and initiate alarms and system controls to halt the process and alert the operator.

[0048] A third embodiment of an applicator apparatus for applying a protective cover to a product is shown in FIGS. 11–18. Referring to FIG. 11, the applicator apparatus 200 includes a magazine 210 which holds a stack of protective covers 212. The magazine includes a base 214 which pushes a pallet 216 in an upward direction so as to maintain the upper level of the magazine at a constant height. A frame 218 includes an alignment fixture 220 which maintains the stack 212 in the proper orientation.

[0049] On the other side of the applicator apparatus 200, a stack of product 222 is supported on a platform 224. In accordance with the system of FIG. 1, the stack of material may be moved by a carriage 226 along a pair of tracks 228a and 228b.

[0050] Between the magazine 210 and product conveyor a frame 230 supports a cover

manipulator 232. The cover manipulator 232 may be moved linearly along the frame 230 from a position adjacent the magazine 210 to a position adjacent the product stack 222 by a transport mechanism 234. The transport mechanism includes a chain or belt 236 which is driven by a motor 238 which, in turn, causes a trolley 240 to which the cover manipulator 232 is attached to move along tracks in the top of the frame 230. The trolley 240 has bearings 241a, 241b, that move on tracks 243a and 243b.

[0051] The cover manipulator 232 includes a structure comprising three arms or slats 242a, 242b and 242c which are coupled to a horizontal beam 244 which rests in bearings 246a and 246b. Each of the three slats 242a, 242b and 242c have three vacuum-coupled suction cups 248. The structure comprising the three slats 242a, 242b and 242c rotates on the beam 244 about its horizontal axis through an angle of 270 degrees as will be explained below under the control of a motor. The height of the cover manipulator 232, which includes the entire structure supported by the trolley 240, is controlled by pneumatic pistons 250a and 250b. Thus, different sizes and configurations of product stacks 222 may be accommodated. In addition to the cover manipulator 232, the trolley 240 also supports a moving cage 252 having opposite side arms 252a and 252b. Each of the arms 252a and 252b include guides with rollers 254a and 254b. There are three of such guides and rollers in vertical alignment on arm 252b and three guides and rollers on arm 252a. There are also four overhead guides and rollers 256 which are also mounted on the cage 252.

[0052] Associated with each of the guides/rollers 254a, 254b and overhead guides/rollers 256 are fastening devices 258 which may be staple guns, riveters, nail guns and the like. The use of the particular form of the fastening device may be left up to the user, it being recognized that many such fastening schemes and mechanisms may be used with the apparatus.

[0053] Referring to FIG. 13, the magazine 210 includes a plurality of protective covers 212 resting upon a moveable pallet mechanism 216. The covers are positioned by the pallet mechanism 216 until they are in proper position and alignment to be grasped by the cover manipulator 232. The covers must be kept at a predetermined height in order for proper operation and the height is automatically maintained by a scissor mechanism 262 operated by a pneumatic piston and cylinder 264. This insures that the top cover of the stack 212 lies in a plane parallel to the plane formed by the suction cups 248 of the cover manipulator 232. The structure formed by the three slats

242a, 242b, 242c along with the vacuum suction cups 248 comprises a cover gripper which is rotatable between a position atop the stack of protective covers (refer to FIG. 14) through a 270 degree arc to a position flush against the side or end of the product 222 (refer to FIG. 15). The product stack, which may be any type of product but is generally one which is in a box-like configuration and which may consist of a stack of substantially flat material such as sheets of plywood, fiberboard or other composite materials, is conveyed along the tracks 228a, 228b to a position adjacent the cover applicator apparatus. Its leading edge is held in place by stops 266a and 266b which are under the control of pneumatic actuator 268. A turntable mechanism 270 pushes upwardly to lift the product stack 222 and rotate it 180 degrees (refer to FIG. 18). The particular form of the turntable mechanism is unimportant and may be pneumatic or may be operated by a screw jack and worm gear or the like. When rotation is completed, the turntable adjusts its height so that the top of the product stack 222 bears against a stop member 272 which sends a signal to the control system that the stack is at the proper height and stops the vertical movement of the turntable 270.

[0054] In operation, the cover manipulator 232 grasps a sheet of protective cover material 212a from the magazine 212 by means of the suction cups 248. The cover manipulator structure 232 is then rotated 270 degrees around the horizontal beam 242 until it aligns with the vertical plane of the stack of material 222. Referring to FIG. 15, the motor 238 then causes the trolley 240 supporting both the cover manipulator 232 and the cage 252 to move forward from a position adjacent the magazine 212 to a position at which the protective cover sheet 232a bears against a vertical side of the product 222. Sensors determine when the cover is properly placed against the stack of material 222. Referring to FIG. 16, once this position is reached the cage 252 moves forward folding the protective cover over the corners and portions of the sides and tops of the product stack 222. This is accomplished under the action of the guide/rollers 254a, 254b and 256. Once the rollers have flattened the top and sides of the protective cover 212a against the stack of material 222, the fasteners 258 are activated which drive staples or the like through the protective cover 232a and fasten it to the material stack 222. As shown in FIG. 18, the cage 252 is withdrawn along with the cover manipulator 232 back to a position adjacent the magazine. The height sensor 272 is withdrawn and the turntable raises the product stack 222 and rotates it 180 degrees in the direction of the arrow. The aforementioned process is then repeated for the opposite side of the product 222.

[0055] In addition to the structures and embodiments disclosed herein, additional modifications and substitutions for various components of the preferred embodiments may be made without departing from the spirit of the invention. For example, the orientation of the magazines holding the protective covers and that of the cover manipulator may be different depending upon the particular application desired. Instead of lying flat on a pallet as shown in FIG. 13, the protective covers could be arranged endwise vertically. That is the covers could be supported in a magazine on their bottom edges parallel to a vertical plane. In such a case the cover manipulator could be rotated 90° so that the structure supporting the cover grippers rotated about a vertical axis instead of a horizontal axis as shown in FIG. 12. Additionally the structure itself could consist of any convenient configuration and, for example, may be a single robotic arm. Additionally the cover gripping mechanism is not limited to the use of suction cups or other vacuum-type devices. In the example given, a robotic arm could have a gripper that included scissor-like friction grippers in the nature of fingers which could grasp each cover from the magazine and hold it for transport over to the product to which it is to be applied.

[0056] The terms and expressions which have been employed in the foregoing specification are used therein as terms of description and not of limitation, and there is no intention, in the use of such terms and expressions, of excluding equivalents of the features shown and described or portions thereof, it being recognized that the scope of the invention is defined and limited only by the claims which follow.